

ENERPTIONS

OVERVIEW PAPER
WATER AND GROUND SOURCE
HEAT PUMPS

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1. INTRODUCTION

With today's escalating heating costs, new and better ways to heat and cool residential, commercial and industrial buildings are being explored.

In particular situations, water and ground source heat pumps are proving to be an effective option. They may be suitable for installation in new buildings and in buildings where the existing system needs to be replaced.

This paper provides an overview of a number of demonstrations of these technologies together with documentation of important lessons learned. Suggestions on resources available are also outlined.

2. CREDA DEMONSTRATIONS

Assistance was provided for a number of heat pump demonstration projects, including groundwater, surface water and ground source units, under the Federal/Provincial Conservation and Renewable Energy Demonstration Agreements (CREDA) Program.

The following demonstration projects provide tangible evidence of the technical and economic feasibility of water and ground source heat pumps as a space conditioning alternative. Detailed Case Studies of these projects, as outlined below, are contained in this ENEROPTIONS package.

ONT 47 Water-Source Heat Pumps - Valley East, Ontario

A new recreational complex is heated using water-to-water heat pumps for space and pool heating. The heat pumps extract heat from groundwater drawn from a supply well. This lowers the temperature of the water which is then returned to the aquifer through a discharge well.

NB 50 Groundwater-Source Heat Pumps - New Brunswick

Groundwater-source heat pump systems were installed in homes and a small commercial building as an alternative to conventional oil-fired systems for heating. Annual savings range between 64% and 73%.

NB 58 Residential Surface Water Source Heat Pump - New Brunswick

Surface water source heat pumps were installed in two New Brunswick homes to supply space heating and domestic hot water requirements using in one case the St. John River and in the other an adjacent pond as a heat source. Annual savings are 63% and 72% respectively.

ONT 60 Vertical Loop Ground-Source Heat Pump - Toronto, Ontario

Existing oil-fired boilers in an industrial shop facility were replaced with glycol-to-water heat pumps which extract heat from the ground using a series of vertically-buried loops.

Many other heat pump projects have been undertaken including Queens Quay Complex on the Toronto harbourfront and many small scale units in Manitoba, Newfoundland and elsewhere. Contact your nearest federal or provincial energy office to learn more.

3. LESSONS LEARNED

. General

Technically these systems performed well and owners generally expressed satisfaction with their units. As is the case with many new technologies, a number of minor problems were reported, but these were generally overcome without significant difficulty.

The economics associated with ground and water sourced heat pumps are highly variable and are affected by the following factors:

- a) site specific factors - the energy requirements for pumping, the depth of the well required, capacity of an existing well to supply the heat pump, and the nature of the building's heating and cooling load.
- b) local factors - charges of equipment suppliers, contractors and drillers.
- c) broad regional factors - climatic conditions, availability of natural gas and relative costs of electricity, oil and other fuels.

In general, the conversion of an existing heating unit to a heat pump is not justified on the basis of energy savings alone. Conversion may be justified in new buildings, or when the cost of replacing the existing heating system and adding air conditioning, are considered.

In residential installations, where the heat pump contributes to domestic hot water requirements, it is more efficient to install a separate preheating water tank, rather than having the heat pump supply heat directly to an existing hot water tank. In this manner, the heat pump can warm the water prior to heating in a conventional tank.

Fluid source heat pumps are normally more reliable than air source units since they operate longer at more constant temperatures and are subjected to fewer stops and starts.

. Groundwater-Source Heat Pumps

There is an element of risk associated with developing new wells. In some cases, two discharge wells are needed to return the flow from a single supply well. In other cases, a single existing artesian well may serve both purposes with supply and return at different elevations in the same well.

Shallow wells may have to be heated to prevent freezing.

Some common concerns associated with wells are the potential plugging of screens and build-up of iron bacteria.

In New Brunswick, a local well drilling firm has expanded its business operation by actively promoting groundwater-source heat pumps.

It is more efficient to use a separate pump to supply water to a heat pump. If the household water supply is used to feed a heat pump, additional energy is expended in raising the pressure of the water for the heat pump to the higher household distribution pressure.

- **Surface Water Source Heat Pumps**

Coils of tubing are placed in a lake or on a river bottom. Heat is extracted from the lake or river source by circulating a working fluid through the coils to a heat pump.

Care must be taken to ensure that the piping is strong enough and adequately secured to withstand river currents and other forces. One collector system, constructed of PVC pipe, plastic fittings and band clamps, had to be replaced with copper pipe when it failed.

Some heat pumps have to be equipped with variable evaporation/condensation set point controls to accommodate the seasonal variations in river or lake temperature (i.e., install a "T-X" valve).

- **Ground-Source Heat Pumps**

In ground-source heat pumps, tubing is buried horizontally or vertically using a series of drilled holes. Heat is extracted from the ground mass by circulating a working fluid through the ground collector loops and then to the heat pump.

Most potential problems, such as restricted flow or contamination associated with groundwater-source units, are eliminated in the ground-source units as the working fluid in a ground-source system circulates in a closed loop.

A fixed set point heat pump can be employed as the temperature of the ground remains relatively constant throughout the year.

A collector system must be designed by a qualified specialist. If too much heat is taken out of the ground mass, or when there is inadequate thermal recharge on a seasonal basis, the following problems can occur:

- a) excessive moisture migration: moisture migrates toward the pipes in winter and away from the pipes during summer
- b) increasingly poor efficiency over several seasons as the ground becomes progressively cooler
- c) cracking and heaving of the ground
- d) delayed plant growth activity due to cooler soil.

4. RESOURCES AVAILABLE

Free technical reports are available on most of the CREDA projects listed above. Addresses of appropriate contacts for follow-up, including equipment suppliers and system designers, are listed at the end of each of the attached ENEROPTIONS Case Studies under the "Further Information" section.

The departments or ministries of energy in each province or territory have information on energy conservation and renewable energy and may have assistance programs. Check your telephone directory for appropriate contacts.

The Conservation and Renewable Energy Offices (CREOs) of Energy, Mines and Resources Canada in each province and territory have information on demonstrations and other assistance programs. Check the back of the attached file folder for the office in your area.

Information on qualified engineering firms by area of specialization and the "Recommended Procedure for the Selection of an Engineer to Provide Professional Services" can be obtained from:

- (a) The Association of Consulting Engineers of Canada
(Re: ENEROPTIONS)
Suite 616
130 Albert Street
Ottawa, Ontario
K1P 5G4
(613) 236-0569

- (b) The consulting engineering organization in your province

Information on innovative financing arrangements may be obtained through the government sources listed above or by contacting:

Martin Adelaar
(Re: ENEROPTIONS)
Energy Management Advisor
Energy Conservation and Oil Substitution Branch
Energy, Mines and Resources Canada
580 Booth Street
Ottawa, Ontario
K1A 0E4
(613) 995-1118